reduced by the competition of the opponent. To ensure a normal growth and yield of rice, therefore, it is important to control barnyardgrass density during the growing seasons.

Key words: Competitive ability, Rice, Barnyardgrass, Chemical composition, Crop season.

# 水稻與稗草競爭關係之探討(四)植體化學分析

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**摘要**：本文研究目的旨在探討臺灣地區兩期作環境下，均質及混植水稻與稗草族群植體化學組成份的改變，以瞭解此兩種植物對營養元素的需要及混植競爭所造成的差異。田間試驗顯示，無論一、二期作稻株植體乾物中的氮(N)、磷(N)、鉀(K)成份比例自移植本田後呈現下降趨勢，鈣(Ca)爲上升曲線，鎂(Mg)則無一致表現(資料未列出)。其中，一期作植體含量大於二期作者而均質族群植株高於混植者。水稻生長期間植體微量元素鐵(Fe)、銅(Cu)、鋅(Zn)、硼(B)、及錳(Mn)之間的變化並無固定趨勢，惟均質族群植株的含量仍大於混植者。稗草植體乾物中的N、P、K含量分別在一期作移植後的54-68天及二期作移植後的57天達到最高值，且除了Mg以外仍然以一期作植株的含量大於二期作者，均質族群植株較混植植株爲高。稗草植體中的微量元素(Fe、Cu、Zn、B、Mn)變化無一定型式，惟均質族群植株的含量亦高於混植者。根據試驗結果，混植水田區的水稻與稗草將互相競爭土壤營養成份，致使其元素吸收量不如均質族群植株，而減少植體中的含量。本文據此建議，爲維持水稻的正常生長及產量，應該採行適當措施控制田間稗草族群密度，降低因競爭土壤營養元素或自然資源對水稻生育造成的干擾。

關鍵語：競爭能力，水稻，稗草，化學成份，期作。

## INTRODUCTION

Barnyardgrass, a major weed found in dryland crops worldwide[3,6], is also a strong competitor in paddy field owing to the similar ecological requirements[2,5,10,17]. Barnyardgrass is a weed of warm regions and requires at least of 160 days per

year of freeze-free period to complete lifecycle [9]. The appropriate ranges of temperature and soil moisture for barnyardgrass germination are 25-30℃ and about 60 % , respectively [16]. Plants of barnyardgrass grow best under wet conditions and can grow in saturated soils or in partially submerged field [8]. Dry matter production of barnyardgrass exceeds that of rice from 25.7 to 27℃ but is reversed below 25.7℃ [7].

It has been reported that barnyardgrass reduced growth and yield of rice when grown in the mixed populations [10,11,12,17]. The magnitude of its influence depends on weed density, growth status of rice, and environmental conditions. Swain (1967) pointed out that rice yield was reduced by 18% at one plant of barnyardgrass per square foot. Smith (1974) showed that season-long competition of barnyardgrass reduced rice yield up to 36% depending on rice cultivars. In Taiwan, field studies indicate that heavy barnyardgrass infestations reduce rice yield by 64% in the first crop and 50% in the second crop [17]. Both growth and yield traits of rice may be affected by the competition of barnyardgrass [3,17].

Barnyardgrass is capable of accumulating considerable amount of macronutrients at the expense of crop plants , especially when the supply of these elements are in shortage [13]. Holm et al. (1977) found that barnyardgrass stands may remove 60-80 % of the nitrogen from the soil, paticularly in the early growing season. It was reported by Vengris et al. (1953) that barnyardgrass was more efficient in phosphorus absorption from the soil than onions and potatoes. However, there is no information in the literature on the changes of macro- and micronutrients of both rice and barnyardgrass grown in the same community throughout the growing period. And, little is known of the differences in these nutrient contents between rice and barnyardgrass under the current cropping system in Taiwan. Such knowledge is important to researchers as well as growers in understanding the nutrient requirements of the two species and in planning weed control practices and farm management.

The present study was to determine the contents of macro- and micronutrients of plants of rice and barnyardgrass grown in different cropping seasons in Taiwan, and to analyze the differences in both plant species grown under competition.

## MATERIALS AND METHODS

The chemical composition of rice and barnyardgrass were analyzed in the first and the second crops of 1994. Plants of rice and barnyardgrass were grown in the experimental farm of Taiwan Agricultural Research Institute on a loam soil. They were seeded at the same time and were transplanted to paddy one plant per hill. The pure stands were planted at a density of 222,000 plants per ha (0.30 m x 0.15 m) on

21 February (First crop) and 9 August 1994 (Second crop), respectively. For mixed stands, barnyardgrass were transplanted between rows of rice 3 d after rice transplanting to a ratio of 1:1, and were replanted a week later to ensure a good establishment. To maintain uniformity, weeds other than barnyardgrass were removed periodically. Fertilizer and pest control were applied as recommended and was tried not to interfere normal growth of the weed.

Experimental plots were arranged as a complete randomized design with three replications. The plots were 2 m (6 rows with 0.30 m apart) by 7 m (plant distance of 0.15 m). Samplings were applied regularly after transplanting. Six plants of each species were collected from each replicate randomly and the aboveground plant parts were mixed , oven-dried ( 80℃ for 72), and ground to powder (passed through 40 mesh) before chemical analysis. The plant mineral composition studied were nitrogen (N), phosphorus (P), potassium (P), calcium (Ca), and magnesium (Mg), which recognized as macronutrients, and iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), and boron (B), which denoted as micronutrients, on a dry-matter basis.

The samples were prepared following wet digestion procedure by 95-97% $H_2SO_4$ and 30% $H_2O_2$ before measurement(4). Nitrogen was measured using colorimetric method (model RFA-300 automated analyzer system, Alpkem Inc., USA) in Indo phenol and P, Ca, Mg, Fe, Mn, Cu, and Zn were analyzed by inductively coupled plasma (ICP) analysis (model Jy-38 plus ICP emission spectrometer, Jobin Yvon Co., France). For K and B analysis, samples were extracted by HCl (1) and then measured in flame photometer (model- 400, Corning Co., USA) for K and by ICP for B. Data were subjected to the statistic analysis and means and standard errors were calculated to compare the differences between treatments.

## RESULTS AND DISCUSSION

On a dry weight basis, contents of N, P, and K of rice plant show a decreasing trend after transplanting in both First and Second crops in 1994 (Figs. 1a and 1b). These elements were generally high in pure stands and low in the mixed ones. The amount of Ca was increased after transplanting and pure stands also had a higher contents. Magnesium was similar to Ca but no differences were found between treatments (data not shown). As results indicated, rice accumulated more macronutrients in the first than in the second cropping seasons.

Although contents of micronutrients, Fe, Cu, Zn, and B, in rice from pure stands were higher than those from the mixed populations, their concentrations varied during the growing periods in either crop (Figs 2a and 2b). Again, plants in the first crop had

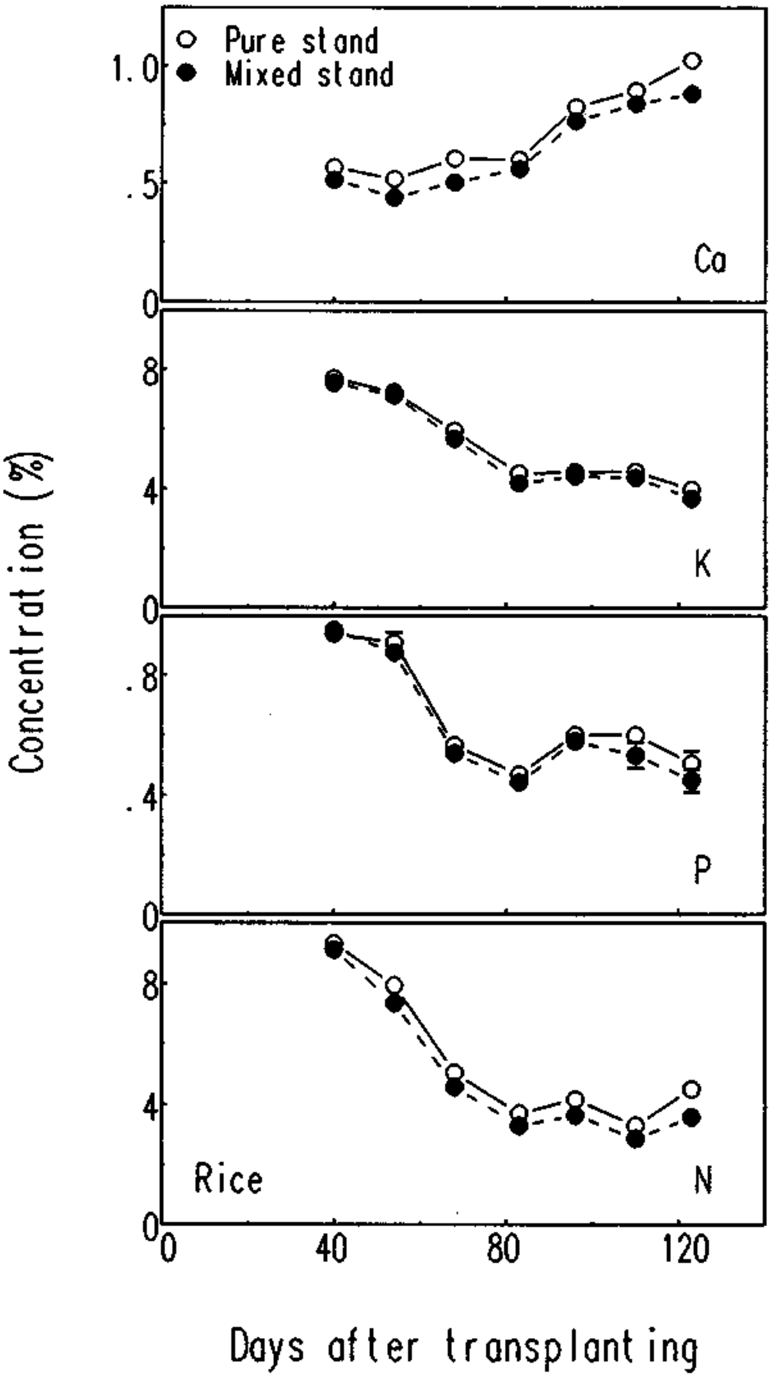


Fig. 1a. Changes of N, P, K, and Ca of rice plants between the pure and the mixed stands grown in the first crop of 1994.

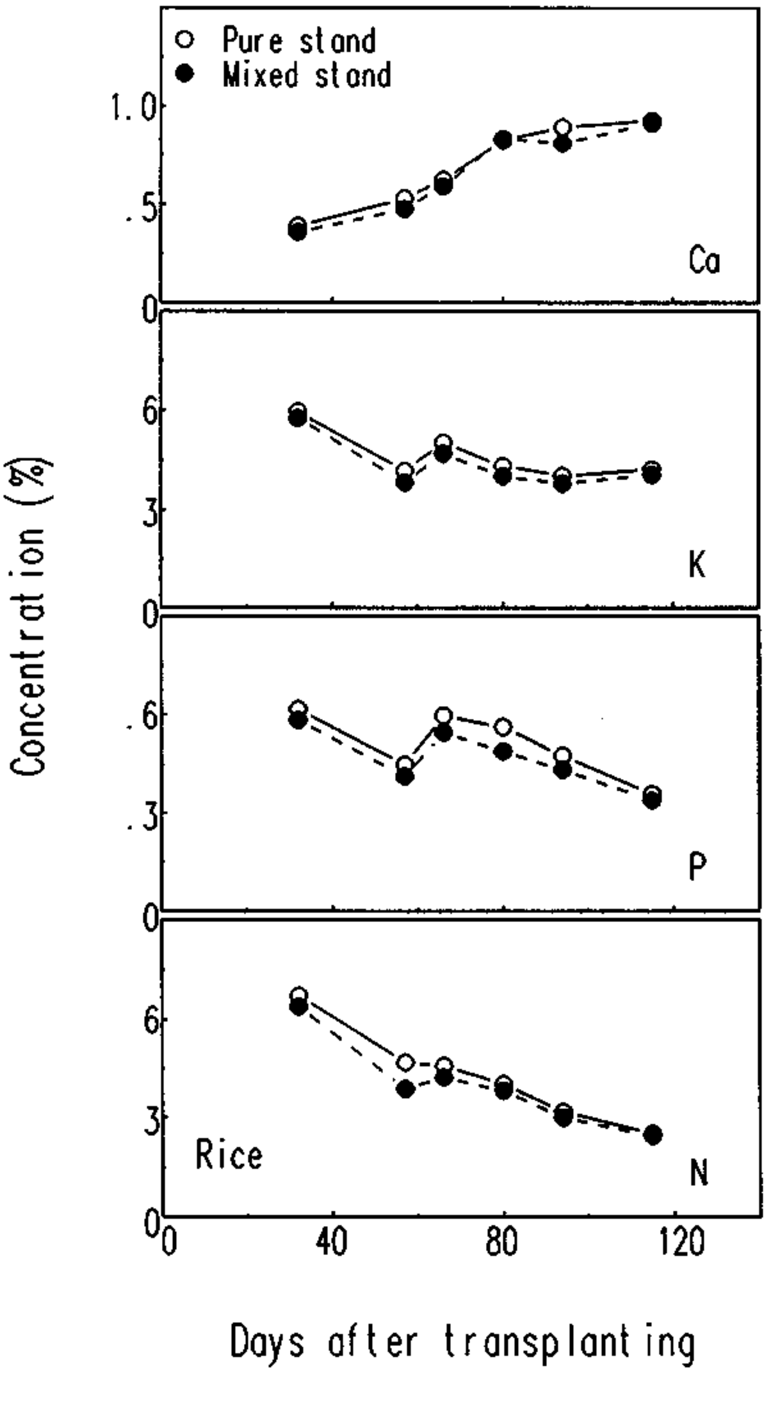


Fig. 1b. Changes of N, P, K, and Ca of rice plants between the pure and the mixed stands grown in the second crop of 1994.

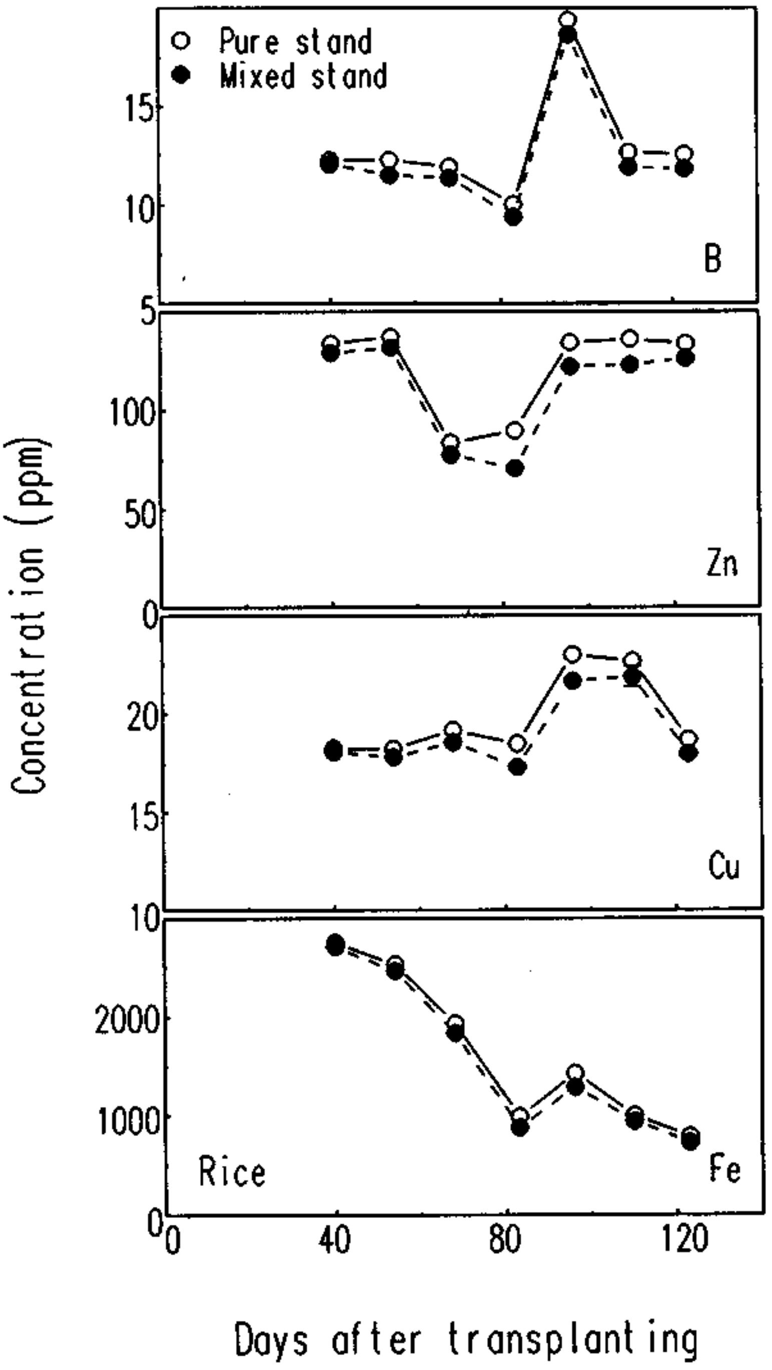


Fig. 2a. Changes of Fe, Cu, Zn, and B of rice plants between the pure and the mixed stands grown in the first crop of 1994.

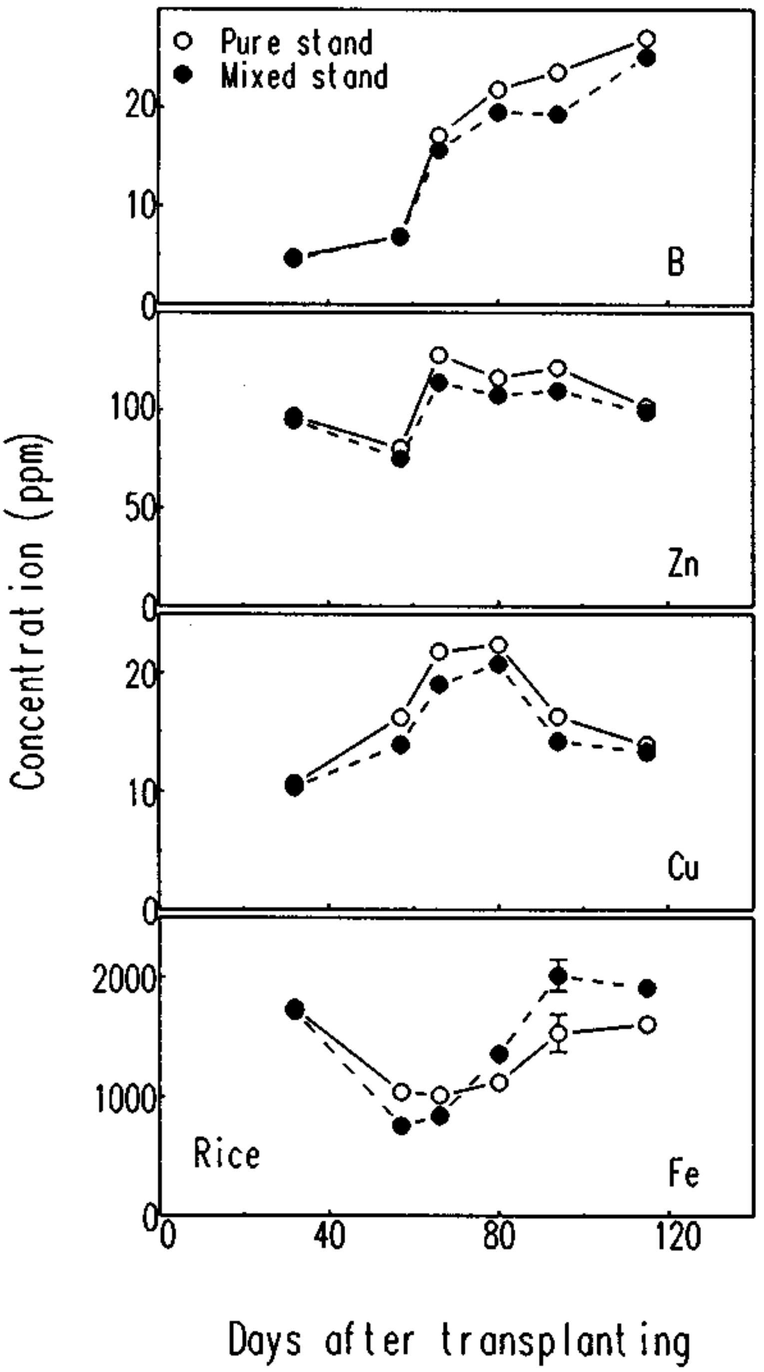


Fig. 2b. Changes of Fe, Cu, Zn, and B of rice plants between the pure and the mixed stands grown in the second crop of 1994.

higher contents than those of the second crop. Manganese had the similar results as these micronutrients (data not shown).

Macronutrients in barnyardgrass reached the maximum at 54-68 and 57 days after transplanting for the first and the second crops, respectively (Figs. 3a and 3b). Except Mg (data not shown), plants from pure stands had higher contents than from the mixed ones. Barnyardgrass grown in First crop also had more of these nutrients than those grown in the second crop. Such scenario was not fitted for micronutrients, while plants of pure stands always have higer concentrations (Figs. 4a and 4b).

As the results shown that the measured macro- and micronutrients were more rich in plants without the competition of other species. That is, either rice or barnyardgrass is a strong competitor for mineral absorption against each other in the paddy field. It suggests that nutrient contents in plants of rice and barnyardgrass will be reduced by the competition of opponent species. Since both species accumulate similar amounts of nutrients in the plant compositions, it implies that barnyardgrass is an important competitor with rice for soil minerals. To ensure a normal growth and yield of rice, therefore, it would be a good practice to control barnyardgrass density during the growing seasons.

The higher values of nutrients in the plant compositions of barnyardgrass propose that barnyardgrass is capable of accumulating soil minerals for extensive propagation in suitable environmental conditions. Moreover, it may continue to grow at the expanse of crop plants including rice under the limited supply of soil minerals. This character makes it a preferred weed species in competiting natural resources with field crops. Nevertheless, the potential role of barnyardgrass as a feed or energy source, based on its richment in minerals, should not be excluded in the future study.

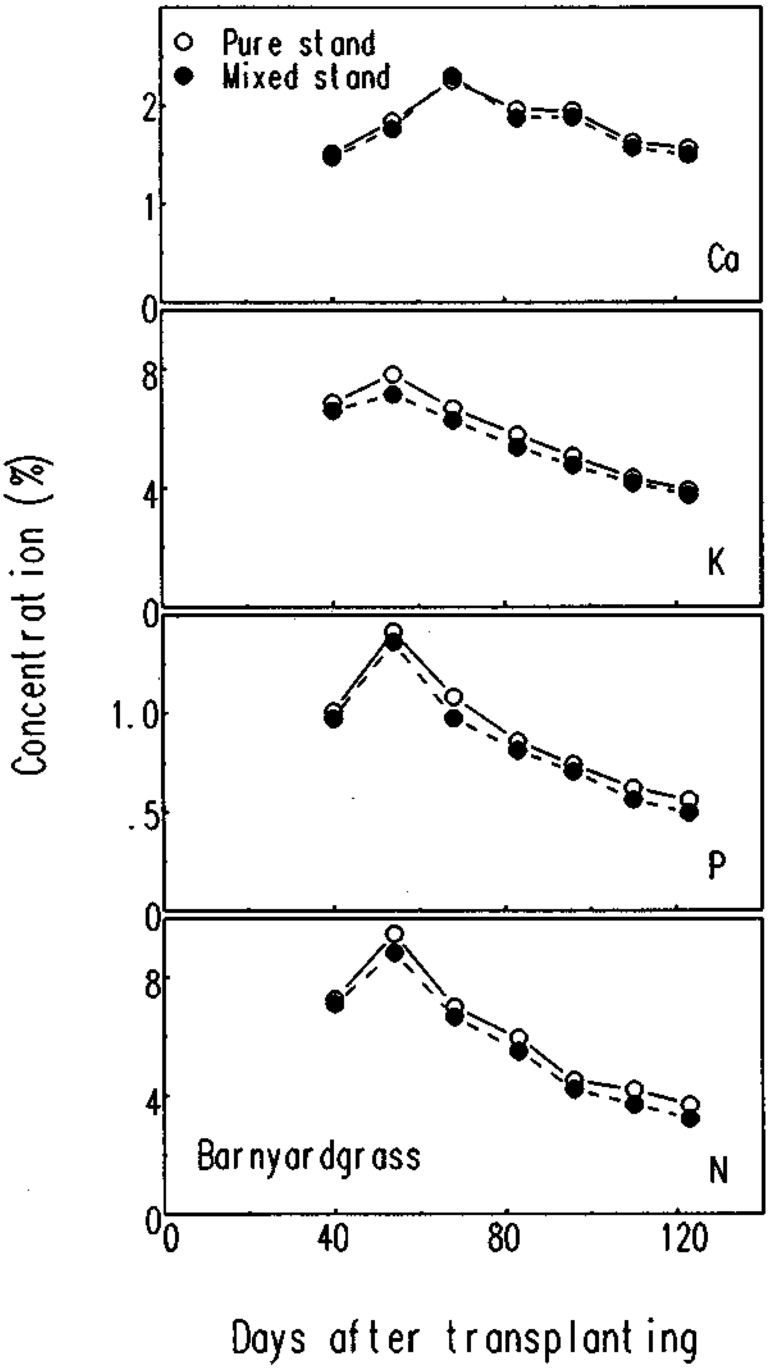


Fig. 3a. Changes of N, P, K, and Ca of barnyardgrass plants between the pure and the mixed stands grown in the first crop of 1994.

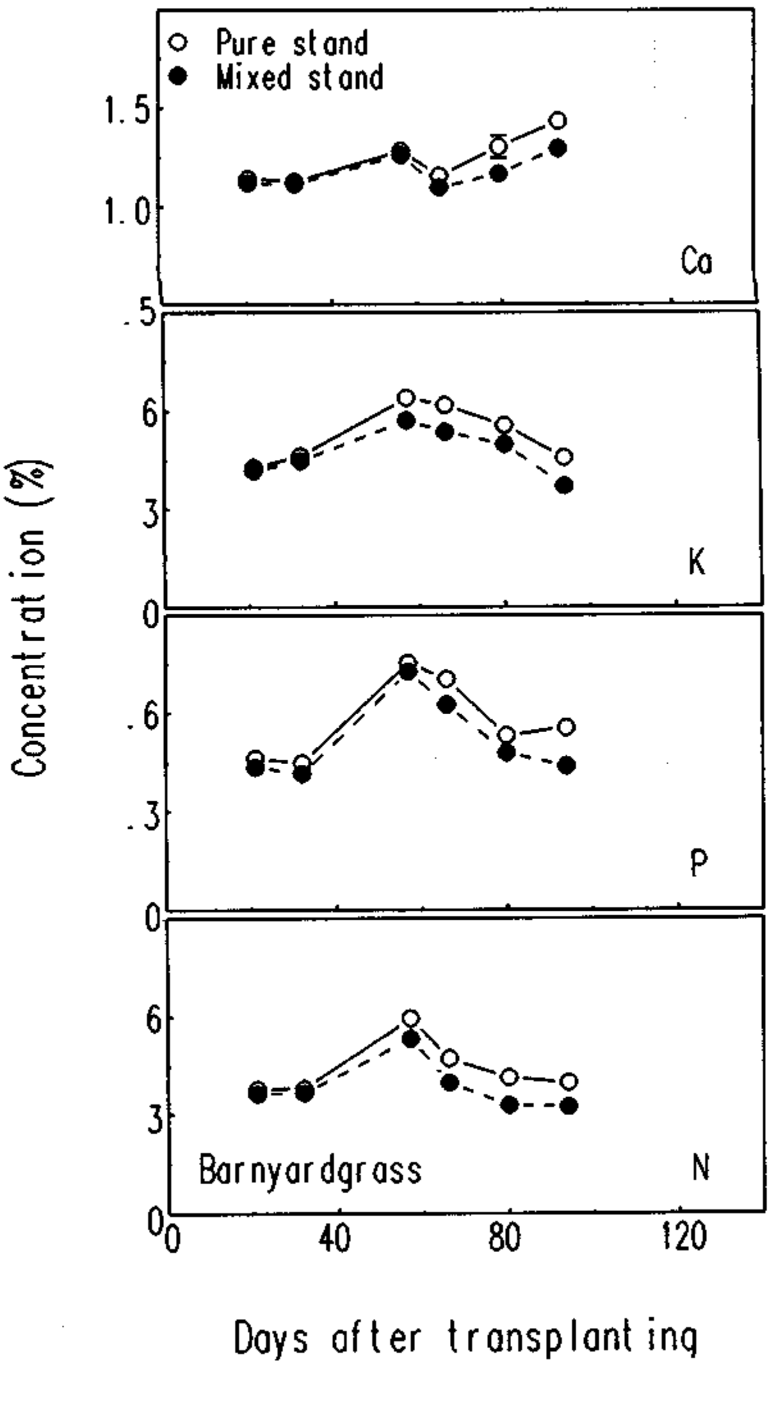


Fig. 3b. Changes of N, P, K, and Ca of barnyardgrass plants between the pure and the mixed stands grown in the second crop of 1994.

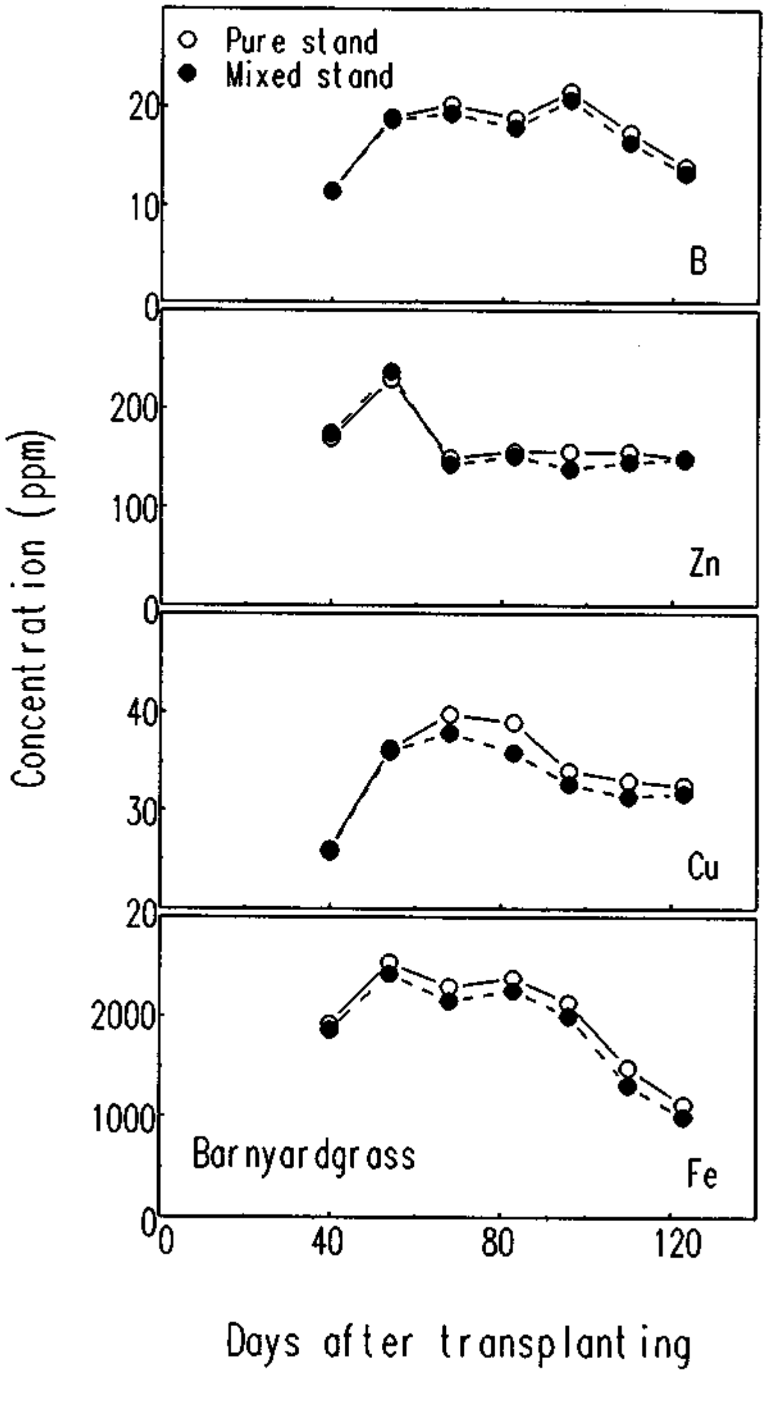


Fig. 4a. Changes of Fe, Cu, Zn, and B of barnyardgrass plants between the pure and the mixed stands grown in the first crop of 1994.

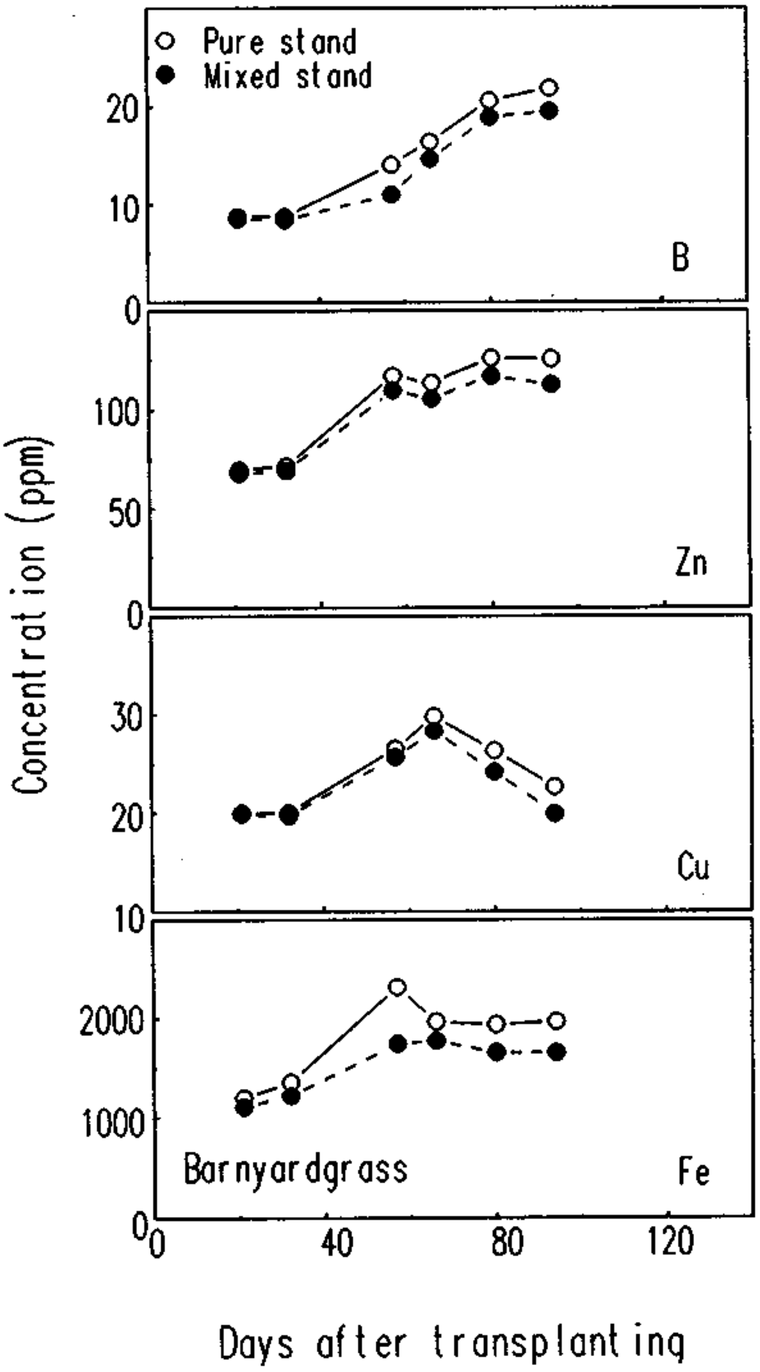


Fig. 4b. Changes of Fe, Cu, Zn, and B of barnyardgrass plants between the pure and the mixed stands grown in the second crop of 1994.

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